Series VS1
Modbus RTU Protocol

9/07 MN744

Important:

Be sure to check **www.baldor.com** for the latest software, firmware and drivers for your VS1 product. Also, you can download the latest version of this manual in Adobe Acrobat PDF format.

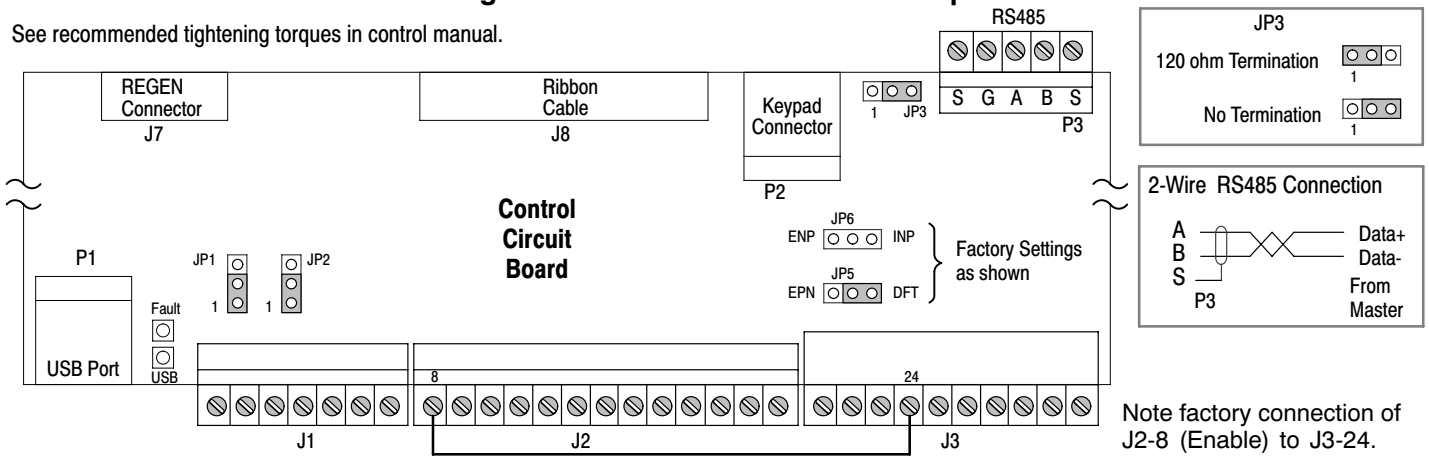
Table of Contents

Modbus Application Layer

MODBUS is an asynchronous serial high-speed binary protocol that supports master/slave communications between the H2 drive and external devices such as host computers, option cards, man machine interfaces, and factory bus gateways. This protocol has three layers. The first layer is known as the Physical Layer (PL) and supports RS485 wiring. The second layer is known as the Data Link Layer (DLL) and supports Remote Terminal Unit protocol, RTU. The third layer is called the Application Layer (AL). This layer supports the host application coils, discrete inputs and holding registers.

This document defines the Application Layer (AL) of this protocol as it relates to the H2 control. The MODBUS connector is P3 which is built into each H2 Control Circuit Board. Refer to Figure 1.

Figure 1 RS485 Connector and Jumper



Definitions

H2 drive	- Next generation of Industrial drives
RTU	- Remote Terminal Unit
PDU	- Protocol Data Unit
DLL	- Data Link Layer
AL	- Application Layer
Master	- A network device (host) that initiates communications
Slave	- A device (like H2 drive) on the network that responds to a command when requested by a master
H or L	- a Modbus Reference followed by an H or L indicates the high or low 16-bit word of a 32-bit number.

RS 485 Connection and Termination

Refer to Figure 1. Connect the RS485 connections as shown to P3 terminals A and B with shield connection to S. Set jumper JP3 as desired (termination or no termination).

RS485 Factory Communication Settings

The factory settings for RS485 serial communication set in the Level 1 Communications parameter block as follows: 19200 Baud, Eight Data Bits, Parity None, 1 Stop Bit, Drive Address 1

Block Title	Parameter	P#	Adjustable Range	Factory
COMMUNICATION	BAUD RATE	1701	0-9600, 1-19200, 2-38400, 3-56000, 4-1 15200	1
	PARITY	1702	0-None, 1-Odd, 2-Even	0
	STOP BITS	1703	0-One, 1-Two	0
	DRIVE ADDRESS	1704	1-247	1
	OPTION CARD RESET	1705	0-OFF, 1-ON	0
	SECURITY DEFAULT	1706	0-NO, 1-YES	0

Modbus Default Addressing Mode

Only the Zero Based Absolute Addressing Mode is supported at this time. In this method of addressing the actual reference number listed in the tables below are sent in the protocol itself. For example, to read holding register 40001, the address 40001 is actually sent in the address field of the protocol.

Application Layer Specification

The host (master) communicates with the H2 drive (the slave) using a predefined list of standard Modbus functions codes. Table 1 summarizes these function codes.

Table 1 Standard Function Code Implementation

H2	Reference Sets	Modbus Standard Function Codes
Control Bits Relay Outputs	Coils (0xxxx)	01 - Read coil Status 15 - Write multiple coils
Status Bits Discrete Inputs	Discrete Inputs (1xxxx)	02 - Read input discrete
Analog Inputs	Input Registers (3xxxx)	04 - Read input register
Control Words Status Words References Parameters	Holding Registers (4xxxx)	03 - Read multiple registers 16 - Write multiple registers
Poll Controller	None	14 - Poll slave after master receives an ACK (05) from a slave to complete the transaction
Data Acquisition	None	68 - Special function used obtaining debug data from H2. • Read Internal Value (internal use only) • Write Internal Value (internal use only) • Configure O-Scope • Control O-Scope • Acquire O-Scope Data • Read Active Fault Codes
Drive Enumeration	None	69 - Workbench connect and enumeration • To Be Determined

Table 2 Data Types

Keyword	Size Bytes	Description	Minimum	Maximum
INT32	4	Double Integer	-2^{31}	$2^{31}-1$
UINT32	4	Unsigned double integer	0	$2^{32}-1$
FLOAT32	4	IEEE floating point std. 754 (single precision)	$\pm 1.175 \times 10^{38}$	$\pm 3.403 \times 10^{38}$

Table 3 MODBUS Exception Codes

Code	Name	Description
01	ILLEGAL FUNCTION	The function code received in the query is not an allowable action for the server (or slave). This may be because the function code is only applicable to newer devices, and was not implemented in the unit selected. It could also indicate that the server (or slave) is in the wrong state to process a request of this type, for example because it is un-configured and is being asked to return register values.
02	ILLEGAL DATA ADDRESS	The data address received in the query is not an allowable address for the server (or slave). More specifically, the combination of reference number and transfer length is invalid. For a controller with 100 registers, a request with offset 96 and length 4 would succeed, a request with offset 96 and length 5 will generate exception 02.
03	ILLEGAL DATA VALUE	A value contained in the query data field is not an allowable value for server (or slave). This indicates a fault in the structure of the remainder of a complex request, such as that the implied length is incorrect. It specifically does NOT mean that a data item submitted for storage in a register has a value outside the expectation of the application program, since the MODBUS protocol is unaware of the significance of any particular value of any particular register.
04	SLAVE DEVICE FAILURE	An unrecoverable error occurred while the server (or slave) was attempting to perform the requested action.
05	ACKNOWLEDGE	Specialized use in conjunction with programming commands. The server (or slave) has accepted the request and is processing it, but a long duration of time will be required to do so. This response is returned to prevent a timeout error from occurring in the client (or master). The client (or master) can next issue a Poll Program Complete message to determine if processing is completed.
06	SLAVE DEVICE BUSY	Specialized use in conjunction with programming commands. The server (or slave) is engaged in processing a long duration program command. The client (or master) should retransmit the message later when the server (or slave) is free.

Coils (Modbus 0xxxx Reference Set)

Coils are read/write control bits. They provide control, source and command features of the Modbus interface. The following standard Modbus functions codes are supported.

Read Coils (Function Code 01)

This function code is used to read the status of from 1 to 2000 contiguous coils in a remote device. The Request PDU specifies the starting address, ie the address of the first coil specified, and the number of coils. Coils are addressed starting at zero. Therefore, coils 1-16 are addressed as 0-15.
The coils in the response message are packed as one coil per bit of the data field. Status is indicated as 1= ON and 0= OFF. The LSB of the first data byte contains the output addressed in the query. The other coils follow toward the high order end of this byte, and from low order to high order in subsequent bytes. If the returned output quantity is not a multiple of eight, the remaining bits in the final data byte will be padded with zeros (toward the high order end of the byte). The Byte Count field specifies the quantity of complete bytes of data.

Request PDU

Function Code	1 Byte	0x01
Starting Address	2 Bytes	0x0000 to 0xFFFF
Quantity of Coils	2 Bytes	1 to 2000 (0x7D0)

Response PDU

Function Code	1 Byte	0x01
Byte Count	1 Byte	N*
Coil Status	n Byte	n=N or N+1

*N = Quantity of outputs/8, if the remainder is different of 0⇒ N=N+1

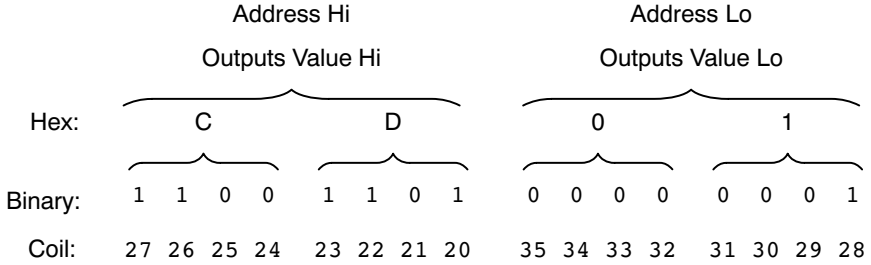
Error

Error Code	1 Bytes	0x0000 to 0xFFFF
Exception Code	1 Bytes	1 to 2000 (0x7D0)

Example of a request to read discrete outputs 20-38:

Request		**Response**	
Field Name	**(Hex)**	**Field Name**	**(Hex)**
Function	01	**Function**	01
Starting Address Hi	00	**Byte Count**	03
Starting Address Low	13	**Output Status 27-20**	CD
Quantity of Outputs Hi	00	**Output Status 35-28**	6B
Quantity of Outputs Lo	13	**Output Status 38-36**	05

The status of outputs 27-20 is shown as the byte value CD hex, or binary 1100 1101. Output 27 is the MSB of this byte, and output 20 is the LSB. By convention, bits within a byte are shown with the MSB to the left, and the LSB to the right. Thus, the outputs in the first byte are '27 through 20', from left to right.
The next byte has outputs '35 through 28', left to right. As the bits are transmitted serially, they flow from LSB to MSB: 20 . . . 27, 28 . . . 35, and so on.
In the last data byte, the status of outputs 38-36 is shown as the byte value 05 hex, or binary 0000 0101. Output 38 is in the sixth bit position from the left, and output 36 is the LSB of this byte. The five remaining high order bits are zero filled.



Write Coils (Function Code 15)

This function code is used to force each coil in a sequence of coils to either ON or OFF in a remote device. The Request PDU specifies the coil references to be forced. Coils are addressed starting at zero. Therefore, coil 1 is addressed as 0.

The requested ON/OFF states are specified by contents of the request data field. A logical '1' in a bit position of the field requests the corresponding output to be ON. A logical '0' requests it to be OFF. The normal response returns the function code, starting address, and quantity of coils forced.

Request PDU

Function Code	1 Byte	0x0F
Starting Address	2 Bytes	0x0000 to 0xFFFF
Quantity of Outputs	2 Bytes	0x0001 to 0x7B0
Byte Count	1 Byte	N*
Outputs Value	N* x 1 Byte	

*N = Quantity of outputs/8, if the remainder is different of 0⇒ N=N+1

Response PDU

Function Code	1 Byte	0x01
Starting Address	2 Bytes	0x0000 to 0xFFFF
Quantity of Outputs	2 Bytes	0x0001 (0x7B0)

Error

Error Code	1 Bytes	0x8F
Exception Code	1 Bytes	01 or 02 or 03 or 04

Example of a request to write a series of 10 coils starting at coil 20:

Request		**Response**	
Field Name	**(Hex)**	**Field Name**	**(Hex)**
Function	0F	**Function**	0F
Starting Address Hi	00	**Byte Count**	00
Starting Address Low	13	**Output Status 27-20**	13
Quantity of Outputs Hi	00	**Output Status 35-28**	00
Quantity of Outputs Lo	0A	**Output Status 38-36**	0A
Byte Count	02		
Outputs Value Hi	CD		
Outputs Value Lo	01		

The request data contents are two bytes: CD 01 hex (1100 1101 0000 0001 binary).

The binary bits correspond to the outputs in the following way:

Bit: 1 1 0 0 1 1 0 1 0 0 0 0 0 0 0 1

Output: 27 26 25 24 23 22 21 20 - - - - - - 29 28

The first byte transmitted (CD hex) addresses outputs 27-20, with the least significant bit addressing the lowest output (20) in this set.

The next byte transmitted (01 hex) addresses outputs 29-28, with the least significant bit addressing the lowest output (28) in this set.

Unused bits in the last data byte should be zero-filled.

Coil Description

Table 4 Coil Table

Modbus Ref	Coils		
	Class	Location	Description (When Set)
00001	VIS	Control Mode Bits 0	NULL MODE - Output stage of control remains off or disabled (voltage and current removed from the motor), regardless of Run Command condition. Drive must be disabled , other mode settings are automatically reset.
00002	VS	Control Mode Bits 1	TORQUE MODE - Closes the current loop with command input from the source selected in the Command Select parameter. Drive must be disabled , other mode settings are automatically reset.
00003	VIS	Control Mode Bits 2	SPEED MODE - Closes the velocity loop with command input from the source selected in the Command Select parameter. Drive must be disabled , other mode settings are automatically reset.
00004	VS	Control Mode Bits 3	ORIENTATION MODE - C or Index channel orientation. The motor will be commanded in the Fwd direction at the predefined homing speed until the index pulse is detected. The motor will then be commanded to hold position at the predefined home offset. Drive must be disabled , other mode settings are automatically reset.
00005	VS	Control Mode Bits 4	POSITION CMD ABS MODE - Closes the position loop with an absolute position command from the Position Ref register. Drive must be disabled , other mode settings are automatically reset.
00006	VS	Control Mode Bits 5	POSITION CMD INC MODE - Closes the position loop with an incremental position command from the Position Ref register. Drive must be disabled , other mode settings are automatically reset.
00007	VS	Control Mode Bits 6	POSITION TRACKING MODE - Closes the position loop in position vs. time tracking mode with command input from the Position Ref register. Optional feed forward from Position Speed. Drive must be disabled , other mode settings are automatically reset. Future Implementation
00008	VS	Control Mode Bits 7	POSITION CMD EXTERNAL MODE - Closes the position loop with command input from an external option source such as pulse follower option card. Drive must be disabled , other mode settings are automatically reset.
00009	S	Control Mode Bits 8	HOMING MODE - Future Implementation
00010	VS	Control Mode Bits 9	PROCESS TORQUE MODE - Closes the torque process control loop. Commands come from the appropriate command input parameters. Drive must be disabled , other mode settings are automatically reset.
00011	VIS	Control Mode Bits 10	PROCESS VELOCITY MODE - Closes the velocity process control loop. Commands come from the appropriate command input parameters. Drive must be disabled , other mode settings are automatically reset.
00012	VS		Reserved
00013	VS	Control Mode Bits 12	NETWORK MODE CURRENT LIMITING - Works with Speed Ref or Hz Speed Ref and current limit network. Drive must be disabled , other mode settings are automatically reset.
00014		Control Mode Bits 13	SECURE COMMUNICATIONS - set to protect Modbus communications settings changing. For example, RESTORE FACTORY SETTINGS would not change the baud rate or protocol currently in effect.
00015		Control Mode Bits 14	JOG CONTROL MODE. Used in conjunction with holding registers JOG CONTROL SPEED REF RPM, JOG CONTROL SPEED REF HZ, and JOG CONTROL ACCEL TIME, JOG CONTROL DECEL TIME. Drive must be disabled to set other modes are automatically reset.
00016 00032		Control Mode Bits 15-31	Coils 16 through 32 are reserved
00033	VIS	Control Source Bit 0	Local - drive placed in local mode
00034	VIS	Control Source Bit 1	Terminal Strip - drive placed in remote mode Note: Input Mode (Level 1 Parameter) must be other than keypad before switch occurs
00035	VIS	Control Source Bit 2	Network. Affects standard-operating modes only. When set “COMMAND SOURCE” (P1402) is replaced with the network equivalent source. For example, in Standard Run analog input 1 is replaced with Network Speed Reference when this coil is ON.
00036	VIS	Control Source Bit 3	Reserved
00037	VIS	Control Source Bit 4	Reserved
00038	VIS	Control Source Bit 5	Parameter Table 1 Select (drive must be disabled)
00039	VIS	Control Source Bit 6	Parameter Table 2 Select (drive must be disabled)
00040	VIS	Control Source Bit 7	Parameter Table 3 Select (drive must be disabled)
00041	VIS	Control Source Bit 8	Parameter Table 4 Select (drive must be disabled)
00042	VIS	Control Source Bit 9	Acc/Dec Group 1 Selected
00043	VIS	Control Source Bit 10	Acc/Dec Group 2 Selected
00044 00064		Control Source Bits 11-31	Coils 44 through 64 are reserved

Table 4 Coil Table Continued

Modbus Ref	Coils		
	Class	Location	Description (When Set)
00066	VIS	Control Command Bit 1	FAULT RESET - 0 write has no effect other than to clear the coil. A write of 1 issues a drive-reset request and attempts to clear all active fault conditions. If successful, operation resumes at previous command. Ignored if no fault is active. Note: maximum number of resets/hour is limited. See user manual details.
00067	VIS	Control Command Bit 2	CLEAR FAULT LOG - positive edge clears the fault log.
00068	VIS	Control Command Bit 3	CLEAR ALL - positive edge clears the fault log and loads factory default parameters into the drive. Drive must be disabled to execute this command.
00069	VIS	Control Command Bit 4	RESTORE FACTORY SETTINGS - positive edge resets all parameters to the initial factory condition in the active parameter table. Drive must be disabled.
00070	VS	Control Command Bit 5	CALCULATE MOTOR MODEL PARAMETERS - positive edge causes calculation motor parameters. Drive must be disabled to perform this operation.
00071	VS	Control Command Bit 6	CALCULATE PRESETS - positive edge causes a calculation of initial values for tuning and performance parameters based on motor nameplate values. Drive must be disabled to perform this operation.
00074	VIS	Control Command Bit 9	CLEAR POSITION COUNTER - positive edge zeros the position counter
00076	VIS	Control Command Bit 11	RESET OPTION CARD 1 - positive edge resets option card 1. If option card is not installed no action is taken
00077	VIS	Control Command Bit 12	RESET OPTION CARD 2 - positive edge resets option card 2. If option card is not installed no action is taken
00078	VIS	Control Command Bit 13	STOP COMMAND - level sensitive, 1 causes the drive to STOP and DISABLE, 0 has no effect. Operating Mode Parameter, P1401, must be set to NETWORK. This input overrides FORWARD, REVERSE and BIPOLAR coils.
00079	VIS	Control Command Bit 14	FORWARD COMMAND - level sensitive, 1 causes the drive to run FORWARD, 0 causes the drive to STOP. Operating Mode Parameter, P1401, must be set to NETWORK and forward enable on J2 must be 1.
00080	VIS	Control Command Bit 15	REVERSE COMMAND - level sensitive, 1 causes the drive to run REVERSE, 0 causes the drive to STOP. Operating Mode Parameter, P1401, must be set to NETWORK and reverse enable on J2 must be 1.
00081	VIS	Control Command Bit 16	BIPOLAR COMMAND - level sensitive, 1 allows the drive to run in FORWARD or REVERSE, 0 causes the drive to STOP. Operating Mode Parameter, P1401, must be set to NETWORK and forward & reverse enables on J2 must be 1.
00082	VIS	Control Command Bit 17	DRIVE ENABLE - level sensitive, 1 enables drive, 0 disables drive. Operating Mode Parameter, P1401, must be set to NETWORK and drive enable on J2 must be 1.
00083	VIS	Control Command Bit 18	Positive Edge Invokes Next Autotuning Test. Will have same action as Command Bits 19 if no more tests in sequence.
00084	VIS	Control Command Bit 19	Positive Edge Ends Autotuning Test Sequence without invoking next test.
00085	VIS	Control Command Bit 20	Positive Edge Aborts ongoing Auto-tune test.
00088 00096		Control Command Bits 23-31	Coils 88 through 96 are reserved
00097	VIS	Control Card	Output 1 - digital, read any time, write in network mode only
00098	VIS	Control Card	Output 2 - digital, read any time, write in network mode only
00099	VIS	Control Card	Output 3 - relay, read any time, write in network mode only
00100	VIS	Control Card	Output 4 - relay, read any time, write in network mode only
00101	VIS	Option Card 1	Output 5 - read any time, write in network mode only
00102	VIS	Option Card 1	Output 6 - read any time, write in network mode only
00103	VIS	Option Card 2	Output 7 - read any time, write in network mode only
00104	VIS	Option Card 2	Output 8 - read any time, write in network mode only
00105 00108		Reserved	Reserved

Control Modes

Digital inputs used in all control modes supported in H2 drives are described in Table 5.
Pre-Conditions: Before a H2 drive can be placed in any of the control modes through Modbus application layer following operating conditions have to be met:

- Drive is disabled (J2- 8 is open)
- Operating Mode parameter (P1401) is set to NETWORK or MINT operating mode.

Note: MINT-operating mode can only be chosen when a Mint Expansion Board is installed in the H2 drive. Mode Control is set to REMOTE as indicated by LOC/REM STATUS parameter (P2).

Table 5 Digital Inputs Used in Control Modes

Digital Input	Name	State	Action
J2-8	ENABLE	OFF	PWM's will be turned off. FWD and REV hardware limits will be ignored. All commands will be ignored.
		ON	PWM's will be enabled. Motion status will depend up on FWD, REV hardware limits.
J2-9	FWD LIMIT	OFF	FORWARD Motion will be inhibited. Treated as hard limit.
		ON	FORWARD Motion will be enabled. Treated as hard limit.
J2-10	REV LIMIT	OFF	REVERSE Motion will be inhibited. Treated as hard limit.
		ON	REVERSE Motion will be enabled. Treated as hard limit.
J2-16	EXTERNAL TRIP	OFF	No Action
		ON	External Fault Active. PWM's will be turned off. FWD and REV hardware limits will be ignored. All commands will be ignored.

Table 6 Control Modes Description

Control Mode	Action	Control Sources/Commands
NULL MODE Turns off PWM's to the inverter gates regardless of run command condition.	Writing '1' to this coil clears all control mode coils and latches (sets) the NULL MODE coil.	Ignored
TORQUE MODE Torque control mode is similar to BIPOLAR operating mode. Closes the current (torque) loop with command input from the source selected in the "Command Source" parameter (P1402)	Writing '1' to this coil will latch (set) the 'TORQUE MODE' coil and will clear all other control mode coils. NOTE: Applicable only in Vector/Servo product variants. Writing'0' to this coil will clear the "TORQUE MODE" coil if it's already SET or else it will be ignored.	Control Source.2 NETWORK: when set to '1' replaces the command source selection to "NETWORK". Same as setting P1402 to "NETWORK". Control Command.13: STOP COMMAND. Writing '1' will issue stop command to the drive. Drive will switch to speed mode with current speed as initial seed to the ramp generator and DECEL TIME#1 as the ramp limit. Will hold zero speed unless J2-8, J2-9 or J2-10 is open. Control Command.17: DRIVE ENABLE. Writing '1' will enable the drive provided J2-8 is closed. Writing '0' will issue a disable command to the drive and PWM's will be turned off and all other control commands will be ignored till this coil is set again. Control Command.14: FORWARD COMMAND. Writing '1' will enable the forward motion provided J2-8 and J2-9 are closed. Writing '0'will issue a STOP command to the drive. Control Command.15: REVERSE COMMAND. Writing '1' will enable the reverse motion provided J2-8 and J2-10 are closed. Writing '0'will issue a STOP command to the drive. Control Command.16: BIPOLAR COMMAND. Writing '1' will enable the forward/reverse motion provided J2-8, J2-9 and J2-10 are closed. Writing '0'will issue a STOP command to the drive. Actual direction of motion will depend on the polarity of torque command. Useful while implementing 3-wire modes. Command Source: P1402. determines the source of torque reference. It could be set of any of the 8 selections except "NONE" or "KEYPAD". If command source is set to "NETWORK" then "TORQUE REFERENCE" holding register (Modbus Reference 40017/18) will become the torque reference source.
ORIENTATION MODE Orient/Homing control mode using the Index or external homing marker signal. Motor will be commanded in the forward direction at "HOMING SPEED" (as set by P2305) until the index or homing marker is detected. Drive will hold this position or at an offset (as set by P2306) of "HOMING OFFSET" from this position.	Writing '1' to this coil will initiate the 'ORIENTATION MODE'. Writing '0' will abort the 'ORIENTATION MODE' if it's already in progress or else it will be ignored. NOTE: Applicable only in Vector/Servo product variants.	Only accel group 1 is used for homing. Control Command.17: DRIVE ENABLE. Writing '1' will enable the drive provided J2-8 is closed. Writing '0' will issue a disable command to the drive and PWM's will be turned off and all other control commands will be ignored till this coil is set again. J2-9 and J2-10 hardware limits must be closed for this mode to work correctly. Homing Speed: P2305. Determines the speed at which search for marker is performed. Homing Offset: P2306. Determines the final homing position. Offset will be added to the position captured at the time of detecting the orientation marker.

Table 6 Control Modes Description Continued

Control Mode	Action	Control Sources/Commands
SPEED MODE Speed control mode is similar to BIPOLAR operating mode. Closes the speed loop with command input from the source selected in the "Command Source" parameter (P1402)	Writing '1' to this coil will latch (set) the 'SPEED MODE' coil and will clear all other control mode coils. NOTE: Applicable only in Vector/Servo product variants. Writing'0' to this coil will clear the "SPEED MODE" coil if it's already SET or else it will be ignored.	Control Source.2 NETWORK: when set to '1' replaces the command source selection to "NETWORK". Same as setting P1402 to "NETWORK".Control Source.9: ACC/DEC Group 1. Selects the accel/decel group 1 for ramp generation. Control Source.10: ACC/DEC Group 2. Selects the accel/decel group 2 for ramp generation. Control Command.13: STOP COMMAND. Writing '1' will issue stop command (sets the internal speed reference to zero) to the drive. Will hold zero speed unless J2-8, J2-9 or J2-10 is open. Control Command.17: DRIVE ENABLE. Writing '1' will enable the drive provided J2-8 is closed. Writing '0' will issue a disable command to the drive and PWM's will be turned off and all other control commands will be ignored till this coil is set again. Control Command.14: FORWARD COMMAND. Writing '1' will enable the forward motion provided J2-8 and J2-9 are closed. Writing '0'will issue a STOP command to the drive. Control Command.15: REVERSE COMMAND. Writing '1' will enable the reverse motion provided J2-8 and J2-10 are closed. Writing '0'will issue a STOP command to the drive. Control Command.16: BIPOLAR COMMAND. Writing '1' will enable the forward/reverse motion provided J2-8, J2-9 and J2-10 are closed. Writing '0'will issue a STOP command to the drive. Actual direction of motion will depend on the polarity of torque command. Useful while implementing 3-wire modes. Command Source: P1402. Determines the source of torque reference. It could be set of any of the 8 selections except "NONE" or "KEYPAD". If command source is set to "NETWORK" then "Hz SPEED REFERENCE" holding register (Modbus Reference 40013/14) or "RPM SPEED REFERENCE" holding register (Modbus Reference 40015/16) will become the speed reference source.
POSITION CMD ABS MODE Position control mode using the absolute position command from the Position Reference register (Modbus Ref 40011/12).	Writing '1' to this coil will initiate the 'POSITION CMD ABS MODE'. Writing '0' will abort the 'POSITION CMD ABS MODE' if it's already in progress or else it will be ignored. NOTE: Applicable only in Vector/Servo product variants.	Control Source.9: ACC/DEC Group 1. Selects the accel/decel group 1 for ramp generation. Control Source.10: ACC/DEC Group 2. Selects the accel/decel group 2 for ramp generation. Control Command.17: DRIVE ENABLE. Writing '1' will enable the drive provided J2-8 is closed. Writing '0' will issue a disable command to the drive and PWM's will be turned off and all other control commands will be ignored till this coil is set again. J2-9 and J2-10 hardware limits must be closed for this mode to work correctly. Position Reference holding register (40011/12) sets the absolute position reference. Position Speed holding register (40025/26) sets the operating speed during positional moves.
POSITION CMD INC MODE Position control mode using the incremental position command from the Position Reference register (Modbus Ref 40011/12).	Writing '1' to this coil will initiate the 'POSITION CMD INC MODE'. Writing '0' will abort the 'POSITION CMD INC MODE' if it's already in progress or else it will be ignored. NOTE: Applicable only in Vector/Servo product variants.	Control Source.9: ACC/DEC Group 1. Selects the accel/decel group 1 for ramp generation. Control Source.10: ACC/DEC Group 2. Selects the accel/decel group 2 for ramp generation. Control Command.17: DRIVE ENABLE. Writing '1' will enable the drive provided J2-8 is closed. Writing '0' will issue a disable command to the drive and PWM's will be turned off and all other control commands will be ignored till this coil is set again. J2-9 and J2-10 hardware limits must be closed for this mode to work correctly. Position Reference holding register (40011/12) sets the new position reference. Position Speed holding register (40025/26) sets the operating speed during positional moves.
POSITION TRACKING MODE Positioning mode using the profiled position (position vs. time) tracking. Initial command is given in the Position Reference register (Modbus Ref 40011/12).	Writing '1' to this coil will initiate the 'POSITION TRACKING MODE'. Writing '0' will abort the 'POSITION TRACKING MODE' if it's already in progress or else it will be ignored. NOTE: Applicable only in Vector/Servo product variants.	Control Source.9: ACC/DEC Group 1. Selects the accel/decel group 1 for ramp generation. Control Source.10: ACC/DEC Group 2. Selects the accel/decel group 2 for ramp generation. Control Command.17: DRIVE ENABLE. Writing '1' will enable the drive provided J2-8 is closed. Writing '0' will issue a disable command to the drive and PWM's will be turned off and all other control commands will be ignored till this coil is set again. J2-9 and J2-10 hardware limits must be closed for this mode to work correctly. Position Reference holding register (40011/12) sets the new position reference. Position Speed holding register (40025/26) sets the operating speed during positional moves. Position FeedForward Tracking Velocity holding register (40027/28) sets the optional feedforward speed to reduce positioning error during tracked positional moves.

Table 6 Control Modes Description Continued

Control Mode	Action	Control Sources/Commands
POSITION CMD EXTERNAL MODE Positioning mode using the external position command from pulse-follower option board.	Writing '1' to this coil will initiate the 'POSITION CMD EXTERNAL MODE. Writing '0' will abort the 'POSITION CMD EXTERNAL MODE if it's already in progress or else it will be ignored. NOTE: Applicable only in Vector/Servo product variants.	Control Source.9: ACC/DEC Group 1. Selects the accel/decel group 1 for ramp generation. Control Source.10: ACC/DEC Group 2. Selects the accel/decel group 2 for ramp generation. Control Command.17: DRIVE ENABLE. Writing '1' will enable the drive provided J2-8 is closed. Writing '0' will issue a disable command to the drive and PWM's will be turned off and all other control commands will be ignored till this coil is set again. J2-9 and J2-10 hardware limits must be closed for this mode to work correctly. Max Speed parameter (P2003) sets the operating speed during positional moves. Details to be developed later.
HOMING MODE No action.	Writing '1' will have no action for time being. Will always read '0'.	No action.
PROCESS TORQUE MODE Process torque control is similar to PROCESS operating mode. Closes the current (torque) loop with set point input from the source selected in the "SETPOINT COMMAND" parameter (P2604), feedback input from the source selected in the "PROC FEEDBACK " parameter (P2603), and feedforward input from the source selected in the "PROC FEEDFORWARD" parameter (P2602).	Writing '1' to this coil will latch (set) the 'PROCESS TORQUE MODE' coil and will clear all other control mode coils. NOTE: Applicable only in Vector/Servo product variants. Writing'0' to this coil will clear the "PROCESS TORQUE MODE" coil if it's already SET or else it will be ignored.	Control Source.2 NETWORK: when set to '1' replaces the command source selection to "NETWORK". Same as setting P1402 to "NETWORK". Control Command.13: STOP COMMAND. Writing '1' will issue stop command to the drive. Drive will switch to speed mode with current speed as initial seed to the ramp generator and DECEL TIME#1 as the ramp limit. Will hold zero speed unless J2-8, J2-9 or J2-10 is open. Control Command.17: DRIVE ENABLE. Writing '1' will enable the drive provided J2-8 is closed. Writing '0' will issue a disable command to the drive and PWM's will be turned off and all other control commands will be ignored till this coil is set again. Control Command.14: FORWARD COMMAND. Writing '1' will enable the forward motion provided J2-8 and J2-9 are closed. Writing '0'will issue a STOP command to the drive. Control Command.15: REVERSE COMMAND. Writing '1' will enable the reverse motion provided J2-8 and J2-10 are closed. Writing '0'will issue a STOP command to the drive. Control Command.16: BIPOLAR COMMAND. Writing '1' will enable the forward/reverse motion provided J2-8, J2-9 and J2-10 are closed. Writing '0'will issue a STOP command to the drive. Actual direction of motion will depend on the polarity of torque command. Useful while implementing 3-wire modes. SETPOINT SOURCE: P2604. Determines the source of torque reference. It could be set of any of the 8 selections except "NONE" or "KEYPAD". If command source is set to "NETWORK" then "PROCESS REFERENCE" holding register (Modbus Reference 40019/20) will become the process torque reference source. PROC FEEDBACK SOURCE: P2603. Determines the source of process feedback. It could be set of any of the 8 selections except "NONE" or "KEYPAD". If process feedback source is set to "NETWORK" then "PROCESS FEEDBACK" holding register (Modbus Reference 40021/22) will become the process feedback source. PROC FEEDFORWARD SOURCE: P2602. Determines the source of process feedforward. It could be set of any of the 8 selections except "NONE" or "KEYPAD". If process feedforward source is set to "NETWORK" then "PROCESS FEEDFORWARD" holding register (Modbus Reference 40023/24) will become the process feedforward source.
AUTO TUNE MODE Not used	Writing '1' has no effect at this time. Always '0'.	No action. Auto tune tests can be invoked directly by writing to action parameters P2901 - P2910. No special action is necessary other than making sure that motor is decoupled from load and J2-8 (ENABLE) is closed. Monitor parameter "MOTION STATUS " (P4) will tell if the drive is in auto tune mode.
JOG CONTROL MODE Allows jogging while in remote network mode	Writing '1' to this coil will latch (set) the 'JOG CONTROL MODE' coil and will clear all other control mode coils. Writing'0' to this coil will clear the "JOG CONTROL MODE" coil if it's already SET or else it will be ignored. NOTE: Drive must be disabled and in Network Mode to set the JOG CONTROL MODE coil	Control Command.13: STOP COMMAND. Writing '1' will issue stop command (sets the internal speed reference to zero) to the drive. Will hold zero speed unless J2-8, J2-9 or J2-10 is open. Control Command.17: DRIVE ENABLE. Writing '1' will enable the drive provided J2-8 is closed. Writing '0' will issue a disable command to the drive and PWM's will be turned off and all other control commands will be ignored till this coil is set again. Control Command.14: FORWARD COMMAND. Writing '1' will enable the forward motion provided J2-8 and J2-9 are closed. Writing '0'will issue a STOP command to the drive. Control Command.15: REVERSE COMMAND. Writing '1' will enable the reverse motion provided J2-8 and J2-10 are closed. Writing '0'will issue a STOP command to the drive. The "Hz JOG REFERENCE" holding register (Modbus Reference 40031/40032) or "RPM JOG REFERENCE" holding register (Modbus Reference 40033/40034) will become the speed reference source. Acceleration and deceleration will be performed at a rate specified by "JOG ACCEL TIME" holding register (Modbus Reference 40035/40036) and "JOG DECEL TIME" holding register (Modbus Reference 40037/40038)

Table 6 Control Modes Description Continued

Control Mode	Action	Control Sources/Commands
PROCESS VELOCITY MODE Process velocity control is similar to PROCESS operating mode. Closes the process velocity loop with set point input from the source selected in the "SETPOINT COMMAND" parameter (P2604), feedback input from the source selected in the "PROC FEEDBACK " parameter (P2603), and feedforward input from the source selected in the "PROC FEEDFORWARD" parameter (P2602).	Writing '1' to this coil will latch (set) the 'PROCESS VELOCITY MODE' coil and will clear all other control mode coils. NOTE: Applicable in Inverter/Vector/Servo product variants. Writing'0' to this coil will clear the "PROCESS VELOCITY MODE" coil if it's already SET or else it will be ignored.	Control Source.2 NETWORK: when set to '1' replaces the command source selection to "NETWORK". Same as setting P1402 to "NETWORK". Control Source.9: ACC/DEC Group 1. Selects the accel/decel group 1 for ramp generation. Control Source.10: ACC/DEC Group 2. Selects the accel/decel group 2 for ramp generation. Control Command.13: STOP COMMAND. Writing '1' will issue stop command (sets the internal speed reference to zero) to the drive. Will hold zero speed unless J2-8, J2-9 or J2-10 is open. Control Command.17: DRIVE ENABLE. Writing '1' will enable the drive provided J2-8 is closed. Writing '0' will issue a disable command to the drive and PWM's will be turned off and all other control commands will be ignored till this coil is set again. Control Command.14: FORWARD COMMAND. Writing '1' will enable the forward motion provided J2-8 and J2-9 are closed. Writing '0'will issue a STOP command to the drive. Control Command.15: REVERSE COMMAND. Writing '1' will enable the reverse motion provided J2-8 and J2-10 are closed. Writing '0'will issue a STOP command to the drive. Control Command.16: BIPOLAR COMMAND. Writing '1' will enable the forward/reverse motion provided J2-8, J2-9 and J2-10 are closed. Writing '0'will issue a STOP command to the drive. Actual direction of motion will depend on the polarity of torque command. Useful while implementing 3-wire modes. SETPOINT SOURCE: P2604. Determines the source of torque reference. It could be set of any of the 8 selections except "NONE" or "KEYPAD". If command source is set to "NETWORK" then "PROCESS REFERENCE" holding register (Modbus Reference 40019/20) will become the process speed reference source. PROC FEEDBACK SOURCE: P2603. Determines the source of process feedback. It could be set of any of the 8 selections except "NONE" or "KEYPAD". If process feedback source is set to "NETWORK" then "PROCESS FEEDBACK" holding register (Modbus Reference 40021/22) will become the process feedback source. PROC FEEDFORWARD SOURCE: P2602. Determines the source of process feedforward. It could be set of any of the 8 selections except "NONE" or "KEYPAD". If process feedforward source is set to "NETWORK" then "PROCESS FEEDFORWARD" holding register (Modbus Reference 40023/24) will become the process feedforward source.
NETWORK MODE CURRENT LIMITING Sets the current limit while in speed control mode. Speed control mode is similar to BIPOLAR operating mode. Closes the speed loop with command input from the source selected in the "Command Source" parameter (P1402). "CURRENT LIMIT" parameter (P1414) should be set 'ON' or else this control mode will be ignored. "CURR LMT SOURCE" parameter (P1415) should be set to "NETWORK".	Writing '1' to this coil will latch (set) the "NETWORK MODE CURRENT LIMITING" coil and will clear all other control mode coils. NOTE: Applicable in Vector/Servo product variants. Writing'0' to this coil will clear the "NETWORK MODE CURRENT LIMITING" coil if it's already SET or else it will be ignored.	Control Source.2 NETWORK: when set to '1' replaces the command source selection to "NETWORK". Same as setting P1402 to "NETWORK". Control Source.9: ACC/DEC Group 1. Selects the accel/decel group 1 for ramp generation. Control Source.10: ACC/DEC Group 2. Selects the accel/decel group 2 for ramp generation. Control Command.13: STOP COMMAND. Writing '1' will issue stop command (sets the internal speed reference to zero) to the drive. Will hold zero speed unless J2-8, J2-9 or J2-10 is open. Control Command.17: DRIVE ENABLE. Writing '1' will enable the drive provided J2-8 is closed. Writing '0' will issue a disable command to the drive and PWM's will be turned off and all other control commands will be ignored till this coil is set again. Control Command.14: FORWARD COMMAND. Writing '1' will enable the forward motion provided J2-8 and J2-9 are closed. Writing '0'will issue a STOP command to the drive. Control Command.15: REVERSE COMMAND. Writing '1' will enable the reverse motion provided J2-8 and J2-10 are closed. Writing '0'will issue a STOP command to the drive. Control Command.16: BIPOLAR COMMAND. Writing '1' will enable the forward/reverse motion provided J2-8, J2-9 and J2-10 are closed. Writing '0'will issue a STOP command to the drive. Actual direction of motion will depend on the polarity of torque command. Useful while implementing 3-wire modes. Command Source: P1402. Determines the source of torque reference. It could be set of any of the 8 selections except "NONE" or "KEYPAD". If command source is set to "NETWORK" then "Hz SPEED REFERENCE" holding register (Modbus Reference 40013/14) or "RPM SPEED REFERENCE" holding register (Modbus Reference 40015/16) will become the speed reference source. "CURRENT LIMIT" parameter (P1414) should be set 'ON' or else this control mode will be ignored. "CURR LMT SOURCE" parameter (P1415) determines the source of current limit. It could be set of any of the 8 selections except "NONE" or "KEYPAD". If current limit source is set to "NETWORK" then "CURRENT LIMIT" holding register (Modbus Reference 40029/30) will act as the current limit.

Discrete Inputs (Modbus 1xxxx Reference Set)

Discrete Inputs in the H2 represent read only status bit for the drive.

Read Discrete Inputs (Function Code 02)

This function code is used to read the status from 1 to 2000 contiguous discrete inputs in a remote device. The Request PDU specifies the starting address, ie the address of the first input specified, and the number of inputs. Inputs are addressed starting at zero. Therefore, inputs 1-16 are addressed as 0-15.

The discrete inputs in the response message are packed as one input per bit of the data field. Status is indicated as 1= ON; 0= OFF. The LSB of the first data byte contains the input addressed in the query. The other inputs follow toward the high order end of this byte, and from low order to high order in subsequent bytes.

If the returned input quantity is not a multiple of eight, the remaining bits in the final data byte will be padded with zeros (toward the high order end of the byte). The Byte Count field specifies the quantity of complete bytes of data.

Request PDU

Function Code	1 Byte	0x02
Starting Address	2 Bytes	0x0000 to 0xFFFF
Quantity of Inputs	2 Bytes	1 to 2000 (0x7D0)

Response PDU

Function Code	1 Byte	0x02
Byte Count	1 Byte	N*
Input Status	n Byte	n=N or N+1

*N = Quantity of outputs/8, if the remainder is different of 0⇒ N=N+1

Error

Error Code	1 Bytes	0x82
Exception Code	1 Bytes	01 or 02 or 03 or 04

Example of a request to read discrete outputs 197-218:

Request	
Field Name	**(Hex)**
Function	02
Starting Address Hi	00
Starting Address Low	C4
Quantity of Inputs Hi	00
Quantity of Inputs Lo	16

Response	
Field Name	**(Hex)**
Function	02
Byte Count	03
Input Status 204-197	AC
Input Status 212-205	DB
Input Status 218-213	35

The status of discrete inputs 204-197 is shown as the byte value AC hex, or binary 1010 1100. Input 204 is the MSB of this byte, and input 197 is the LSB.

The status of discrete inputs 218-213 is shown as the byte value 35 hex, or binary 0011 0101. Input 218 is in the third bit position from the left, and input 213 is the LSB.

Discrete Input Description

In Table 7, Bit 0 indicates the Least Significant Bit (LSB) of a 32-bit word.

Table 7 Discrete Inputs Table

Modbus Ref	**Discrete Inputs**	
	Location	**Description**
10001	Drive Status1 Bit 0	Enable - active high when the drive hardware enable is high
10002	Drive Status1 Bit 1	Ready - active high when the drive is enabled and no faults exist and ready to accept a speed or torque command
10003	Drive Status1 Bit 2	Drive On - active high when drive is ready and capable of generating torque
10004	Drive Status1 Bit 3	Forward Command - active high when drive is ready and has a positive speed demand, clockwise looking at the shaft. Not used in torque mode.
10005	Drive Status1 Bit 4	Reverse Command - active high when drive is ready and has a negative speed demand, counterclockwise looking at the shaft. Not used in torque mode.
10006	Drive Status1 Bit 5	Stop - active high when drive is ready and has a zero speed demand. Not active in torque mode.
10007	Drive Status1 Bit 6	Jog - active high while drive is in jog mode
10008	Drive Status1 Bit 7	Motor Forward - motor turning in forward direction, clockwise looking at the shaft
10009	Drive Status1 Bit 8	Motor Reverse - motor turning in reverse direction, clockwise looking at the shaft
10010	Drive Status1 Bit 9	Torque Mode - active high when the drive is in vector torque mode

Table 7 Discrete Inputs Table Continued

Modbus Ref	Discrete Inputs	
	Location	**Description**
10011	Drive Status1 Bit 10	Speed Mode - active high when drive is in vector speed mode
10012	Drive Status1 Bit 11	V/F mode - active high when drive is in inverter mode
10013	Drive Status1 Bit 12	Flash Boot Mode - active high when the drive is in flash boot mode
10014	Drive Status1 Bit 13	Closed Loop Vector Mode - active high when drive is in vector mode and encoder is functioning properly
10015	Drive Status1 Bit 14	Open Loop Vector Mode - active high when drive is in vector mode without an encoder
10016	Drive Status1 Bit 15	BLDC Mode - active high when drive is in brush less DC (servo) mode
10017	Drive Status1 Bit 16	Dynamic Brake ON - active high while dynamic brake is turned on
10018	Drive Status1 Bit 17	Foldback Active - active high while drive is in current limit with reduced frequency output
10019	Drive Status1 Bit 18	Drive Fault Active - active high while a fault is active
10020	Drive Status1 Bit 19	Drive Warning Active - active high while a warning is active
10021	Drive Status1 Bit 20	At Speed - active high while drive is within the speed band of its reference speed source
10022	Drive Status1 Bit 21	At Zero Speed - active high while drive is within its zero speed band
10023	Drive Status1 Bit 22	Following Error - active high when motor speed is outside the user specified tolerance band defined by the At Speed Band Parameter
10024	Drive Status1 Bit 23	Overload - active high when an over current fault exists resulting from an I2T timeout
10025	Drive Status1 Bit 24	Accelerate - output from speed/position profiler when drive is under acceleration
10026	Drive Status1 Bit 25	Constant Speed - output from speed/position profiler when the drive at constant speed
10027	Drive Status1 Bit 26	Decelerate - output from speed/position profiler when the drive is under deceleration
10028	Drive Status1 Bit 27	Keypad Control - active high when keypad is in local mode
10029	Drive Status1 Bit 28	At Position - active high when actual position is within the position band of the drive. Not implemented on open loop products.
10030	Drive Status1 Bit 29	At Home. Active high when at home position.
10031	Drive Status1 Bit 30	Process Error - active high when the process feedback is outside the AT Setpoint Band Parameter in the Process Control Parameter Block
10032	Drive Status1 Bit 31	Network Control - active high when the drive is in network mode and using network reference signal
10033	Drive Status2 Bit 0	Positive Torque Command - (torque mode only)
10034	Drive Status2 Bit 1	Negative Torque Command - (torque mode only)
10035	Drive Status2 Bit 2	At Speed Band
10036	Drive Status2 Bit 3	At Set Speed
10037	Drive Status2 Bit 4	Motor Current Overload
10038	Drive Status2 Bit 5	Motor Current Underload
10039 10064	Drive Status2 Bit 6-31	Discrete Inputs 39 through 64 are reserved
10065	Control Card	Digital Input 1 (drive enable)
10066	Control Card	Digital Input 2
10067	Control Card	Digital Input 3
10068	Control Card	Digital Input 4
10069	Control Card	Digital Input 5
10070	Control Card	Digital Input 6
10071	Control Card	Digital Input 7
10072	Control Card	Digital Input 8
10073	Control Card	Digital Input 9
10074	Control Card	Reserved
10075	Control Card	Reserved
10076	Control Card	Reserved
10077	Control Card	Reserved
10078	Control Card	Reserved
10079	Control Card	Reserved
10080	Control Card	Reserved

Inputs (Modbus 3xxxx Reference Set)

Analog inputs are mapped to Modbus Inputs for H2.

Read Input Registers (Function Code 04)

This function code is used to read from 1 to approx. 125 contiguous input registers in a remote device. The Request PDU specifies the starting register address and the number of registers. Registers are addressed starting at zero. Therefore, input registers 1-16 are addressed as 0-15.
The register data in the response message are packed as two bytes per register, with the binary contents right justified within each byte.
For each register, the first byte contains the high order bits and the second contains the low order bits.

Request PDU

Function Code	1 Byte	0x04
Starting Address	2 Bytes	0x0000 to 0xFFFF
Quantity of Inputs	2 Bytes	0x0001 to 0x7D0

Response PDU

Function Code	1 Byte	0x04
Byte Count	1 Byte	2xN*
Input Status	N* x 2 Bytes	

*N = Quantity of Input Registers

Error

Error Code	1 Bytes	0x84
Exception Code	1 Bytes	01 or 02 or 03 or 04

Example of a request to read input register 9:

Request	
Field Name	**(Hex)**
Function	04
Starting Address Hi	00
Starting Address Low	08
Quantity of Input Reg Hi	00
Quantity of Input Reg Lo	01

Response	
Field Name	**(Hex)**
Function	04
Byte Count	02
Input Reg 9 Hi	00
Input Reg 9 Lo	0A

Table 8 Input Table

Modbus Ref	**Inputs**	
	Location	**Description**
30001L	Control Card	Analog Input 1 - ±100% IEEE floating point
30002H	Control Card	Analog Input 1 - ±100% IEEE floating point
30003L	Control Card	Analog Input 2 - ±100% IEEE floating point
30004H	Control Card	Analog Input 2 - ±100% IEEE floating point
30005L	Option Card 1	Analog Input 3 - ±100% IEEE floating point
30006H	Option Card 1	Analog Input 3 - ±100% IEEE floating point
30007L	Option Card 1	Analog Input 4 - ±100% IEEE floating point
30008H	Option Card 1	Analog Input 4 - ±100% IEEE floating point
30009L	Option Card 2	Analog Input 5 - ±100% IEEE floating point
30010H	Option Card 2	Analog Input 5 - ±100% IEEE floating point
30011L	Option Card 2	Analog Input 6 - ±100% IEEE floating point
30012H	Option Card 2	Analog Input 6 - ±100% IEEE floating point

Holding Registers (Modbus 4xxxx Reference Set)

Holding registers are the primary mechanism by which a master gains access to key control features of the H2 and its parameters.

Read Holding Registers (Function Code 03)

This function code is used to read the contents of a contiguous block of holding registers in a remote device. The Request PDU specifies the starting register address and the number of registers. Registers are addressed starting at zero. Therefore, registers 1-16 are addressed as 0-15.

The register data in the response message are packed as two bytes per register, with the binary contents right justified within each byte. For each register, the first byte contains the high order bits and the second contains the low order bits.

Request PDU

Function Code	1 Byte	0x03
Starting Address	2 Bytes	0x0000 to 0xFFFF
Quantity of Registers	2 Bytes	1 to 125 (0x7D)

Response PDU

Function Code	1 Byte	0x04
Byte Count	1 Byte	2xN*
Register Value	N* x 2 Bytes	

*N = Quantity of Input Registers

Error

Error Code	1 Bytes	0x83
Exception Code	1 Bytes	01 or 02 or 03 or 04

Example of a request to read registers 108-110:

Request	
Field Name	**(Hex)**
Function	03
Starting Address Hi	00
Starting Address Low	6B
Quantity of Registers Hi	00
Quantity of Registers Lo	03

Response	
Field Name	**(Hex)**
Function	03
Byte Count	06
Register Value Hi (108)	02
Register Value Lo (108)	2B
Register Value Hi (109)	00
Register Value Lo (109)	00
Register Value Hi (110)	00
Register Value Lo (110)	64

The contents of register 108 are shown as the two-byte values of 02 2B hex, or 555 decimal. The contents of registers 109-110 are 00 00 and 00 64 hex, or 0 and 100 decimal, respectively.

Write Holding Registers (Function Code 16)

This function code is used to write a block of contiguous registers (1 to approx. 120 registers) in a remote device. The requested written values are specified in the request data field. Data is packed as two bytes per register. The normal response returns the function code, starting address, and quantity of registers written.

Request PDU

Function Code	1 Byte	0x10
Starting Address	2 Bytes	0x0000 to 0xFFFF
Quantity of Registers	2 Bytes	0x0001 to 0x0078
Byte Count	1 Byte	2xN*
Register Value	N* x 2 Bytes	value

Response PDU

Function Code	1 Byte	0x10
Starting Address	2 Bytes	0x0000 to 0xFFFF
Quantity of Registers	2 Bytes	1 to 123 (0x7B)

Error

Error Code	1 Bytes	0x90
Exception Code	1 Bytes	01 or 02 or 03 or 04

Example of a request to write two registers starting at 2 to 00 0A and 01 02 hex:

Request	
Field Name	**(Hex)**
Function	10
Starting Address Hi	00
Starting Address Low	01
Quantity of Registers Hi	00
Quantity of Registers Lo	02
Byte Count	04
Registers Value Hi (Low Byte)	00
Registers Value Lo (Low Byte)	0A
Registers Value Hi (High Byte)	01
Registers Value Lo (High Byte)	02

Response	
Field Name	**(Hex)**
Function	10
Starting Address Hi	00
Starting Address Low	01
Quantity of Registers Hi	00
Quantity of Registers Lo	02

Holding Register Table

This section contains a detailed list of the holding registers supported by the H2 Modbus Interface.
The list includes the holding register address, name, type, class, data field and description, and a detailed specification of the required and returned data.
The type field is simply Read (R), Write (W), or Read/Write (R/W).
The class field is V (Closed Loop Vector), I (Inverter or Open Loop Vector) or S (Servo).
The data field is one of INT32, UINT32 or FLOAT32 as defined in the table above.
The description field gives information regarding the use of the register. When possible the data range, scale, units, etc. are also given. An asterisk is used to indicate default power up values where applicable.

Table 9 Holding Register Table

Modbus Ref		Holding Registers			
	Name	**Class**	**Type**	**Data**	**Description**
40001 40002	Control Mode	VIS	R	UNIT32[1]	Mode of Operation for the Drive. Must use coils to configure modes.
40003 40004	Control Source	VIS	R/W	UNIT32[1]	Sets Reference Sources for Drive
40005 40006	Control Command	VIS	R/W	UNIT32[1]	Executes Drive Commands
40007 40008	Drive Status 1	VIS	R	UNIT32[1]	Drive Status 1
40009 40010	Drive Status 2	VIS	R	UNIT32[1]	Drive Status 2
40011 40012	Position Reference	VS	R, R/W	FLOAT32[1]	Holds current Position Reference. R/W in Network Mode. Units = quadrature counts. Scaling = 1; 4x feedback counts per rev
40013 40014	Hz Speed Reference	I	R, R/W	FLOAT32[1]	Holds current Hz Speed Reference. R/W in Network Mode. Min = 0; Max = 500Hz. Resolution: 0.01Hz
40015 40016	RPM Speed Reference	VS	R, R/W	FLOAT32[1]	Holds current RPM Speed reference. R/W in Network Mode. Units: RPM. Min = 0; Max = 30000 RPM; Resolution: Varies* (0.01RPM minimum)
40017 40018	Torque Reference	VS	R, R/W	FLOAT32[1]	Holds current Torque reference. R/W in Network Mode. Scaling: ±100% = programmed current limit.. Resolution: 0.01%
40019 40020	Process Reference	VIS	R, R/W	FLOAT32[1]	Holds current Process Control Reference R/W in Network Mode. Scaling: ±100% = ±28bits Internal. Resolution: 0.01%
40021 40022	Process Feedback	VIS	R, R/W	FLOAT32[1]	Holds current Process Control Feedback. R/W in Network Mode. Scaling: ±100%. Resolution: 0.01%
40023 40024	Process Feed Forward	VIS	R, R/W	FLOAT32[1]	Holds current Process Control Feed Forward. R/W in Network Mode. Scaling: ±100%. Resolution: 0.01%
40025 40026	Position Speed	VS	R, R/W	FLOAT32[1]	Holds current Positioning Speed Reference. R/W in Network Mode. Max speed used for positioning commands. Also referred to as feed rate or target velocity. Units: RPM Min = 0; Max = 30000 RPM; Resolution: Varies* (0.01RPM minimum)
40027 40028	Position Feed Forward	S	R, R/W	FLOAT32[1]	Holds current Position Tracking Feedforward. R/W in Network Mode. Optional commanded velocity used to reduce error in tracking command. Units: RPM Min = 0; Max = 30000 RPM; Resolution: Varies* (0.01RPM minimum)
40029 40030	Current Limit	VS	R, R/W	FLOAT32[1]	Holds most recent Current Limit. R/W in Network Mode. Units: % Range: 0 - 100% of programmed drive peak current

Table 9 Holding Register Table Continued

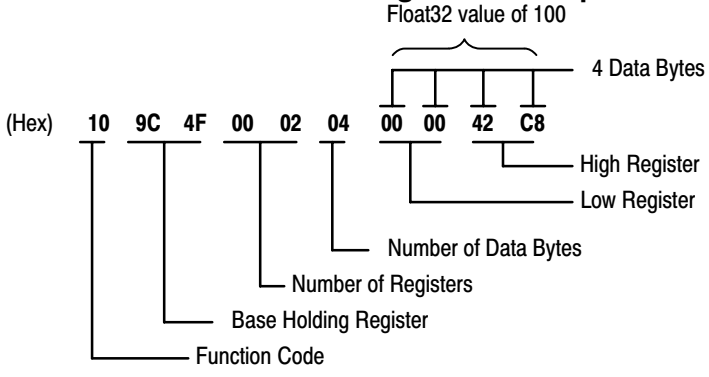
Modbus Ref		Holding Registers			
	Name	Class	Type	Data	Description
40031 40032	Jog Control Speed Hz	VIS	R, R/W	FLOAT32[1]	Slew speed in Hz for use with Jog Control Mode. R/W in network mode
40033 40034	Jog Control Speed RPM	VIS	R, R/W	FLOAT32[1]	Slew speed in RPM for use with Jog Control Mode. R/W in network mode
40035 40036	Jog Control Accel Time	VIS	R, R/W	FLOAT32[1]	Accel time for use with Jog Control. R/W in network mode
40037 40038	Jog Control Decel Time	VIS	R, R/W	FLOAT32[1]	Decel time for use with Jog Control. R/W in network mode.
40101 40102	DAC Output #1	VIS	R, R/W	FLOAT32[1]	Control Card DAC 1. R/W and pre-gain in Network Mode. RO and post-gain otherwise. 0-100% uni-polar D/A converter #1.
40103 40104	DAC Output #2	VIS	R, R/W	FLOAT32[1]	Control Card DAC 2. R/W and pre-gain in Network Mode. RO and post-gain otherwise. ±100% bipolar signal of D/A converter #2.
40105 40106	DAC Output #3	VIS	R, R/W	FLOAT32[1]	AC 1. R/W and pre-gain in Network Mode. RO Option Card 1 D and post-gain otherwise. ±100% bipolar signal of D/A converter #3.
40107 40108	DAC Output #4	VIS	R, R/W	FLOAT32[1]	Option Card 1 DAC 2. R/W and pre-gain in Network Mode. RO and post-gain otherwise. ±100% bipolar signal of D/A converter #4.
40109 40110	DAC Output #5	VIS	R, R/W	FLOAT32[1]	Option Card 2 DAC 1. R/W and pre-gain in Network Mode. RO and post-gain otherwise. ±100% bipolar of D/A converter #5.
40111 40112	DAC Output #6	VIS	R, R/W	FLOAT32[1]	Option Card 2 DAC 2. R/W and pre-gain in Network Mode. RO and post-gain otherwise. ±100% bipolar of D/A converter #6.
40201 40202	Network Watchdog Timeout	VIS	R/W	UNIT32[1]	Set network watchdog timer. Units: ms, 0 = disable, enabled by first non-zero write Resolution: 10 ms Min = 10 ms; Max = 6000 ms Once enabled, it should be written to within the timeout period else Network watchdog timeout fault occurs.
40203 40204	Software Reset Counter	VIS	R/W	UNIT32[1]	This register is cleared at power up and increment on a hardware watchdog timeout.

Note 1: For 32-bit data, the lower register number contains the lower order 16-bit data and the higher register number contains the higher order 16-bit data. In addition, when reading or writing 32-bit data, the lower 16-bit register must be accessed first before the upper 16-bit register.

Table 10 Holding Register Table

41000 . . . 49999	H2 Parameters	VIS	R/W		H2 parameters are mapped to 41000 series registers. All H2 parameter are 32 bits. Holding register numbers for parameter are computed as follows: HRN is the Holding Register Number and PN is the Parameter Number Where: HRN = 2*PN + 41000 Example: Preset Speed 1 has parameter number P1001 therefore, its HRN number is: HRN = 2*1001+41000 = 43002 With, 43002 (low order 16-bit data) 43003 (high order 16-bit data)

Figure 2 Example PDU to Send 100 RPM Request



Text Handling (H2 Function Code 66)

These sub-functions are used to support text-handling functions.

Read Parameter Name Text (Sub-Code 1)

This PDU is used to read parameter names from the control card.

Request PDU

Byte 1	Byte 2	Byte 3	Byte 4
Function Code (66)	Sub-Code (1)	PN H	PN L

Where,

Byte 1: Text Handing Function Code 66 (0x42)
Byte 2: Read Parameter Name Sub-Code
Byte 3-4: 16-Bit Parameter Number (PN)

Response PDU:

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	...	Byte N-1	Byte N
Function Code (66)	Sub-Code (1)	PN H	PN L	ASCII	...	ASCII	NULL

Where,

Byte 5 - N: Parameter Name
Null Terminated ASCII String of up to 16 characters
Language Determined by Drive Parameter

Read Parameter Help Text (Sub-Code 2)

This PDU is used to read parameter help text from the control card.

Request PDU

Byte 1	Byte 2	Byte 3	Byte 4
Function Code (66)	Sub-Code (2)	PN H	PN L

Where,

Byte 1: Text Handing Function Code 66 (0x42)
Byte 2: Read Parameter Name Sub-Code
Byte 3-4: 16-Bit Parameter Number (PN)

Response PDU:

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	...	Byte N-1	Byte N
Function Code (66)	Sub-Code (2)	PN H	PN L	ASCII	...	ASCII	NULL

Where,

Byte 5-N: Parameter Help Text
Null Terminated ASCII String of up to 126 characters
Language Determined by Drive Parameter

Read List Parameter Text (Sub-Code 3)

This PDU is used to read list parameter list text from the control card.

Request PDU

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6
Function Code (66)	Sub-Code (3)	PN H	PN L	Index H	Index L

Where,

Byte 1: Text Handing Function Code 66 (0x42)
Byte 2: Read List Parameter List Text Sub-Code
Byte 3-4: 16-Bit Parameter Number (PN)
Byte 5-6: 16-Bit Index (1-Max) into List

Response PDU:

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	...	Byte N-1	Byte N
Function Code (66)	Sub-Code (3)	PN H	PN L	ASCII	...	ASCII	NULL

Where,

Bytes 7 - N: Parameter List Text
Null Terminated ASCII String of up to 16 characters
Language Determined by Drive Parameter

Text Handling Continued

Read List Parameter Text (Sub-Code 4)

This PDU is used to read fault code text.

Request PDU

Byte 1	Byte 2	Byte 3	Byte 4
Function Code (66)	Sub-Code (4)	Fault Code H	Fault Code L

Where,

Byte 1: Text Handing Function Code 66 (0x42)
Byte 2: Read Fault Code Text Sub-Code
Byte 3-4: 16-Bit Fault Code Number

Response PDU:

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	...	Byte N-1	Byte N
Function Code (66)	Sub-Code (4)	Fault Code H	Fault Code L	ASCII	...	ASCII	NULL

Where,

Byte 5 - N: Fault Code Text
Null Terminated ASCII String of up to 16 characters
Language Determined by Drive Parameter

Read Software Version Text (Sub-Code 5)

This PDU is used to read the software version number.

Request PDU

Byte 1	Byte 2
Function Code (66)	Sub-Code (5)

Where,

Byte 1: Text Handing Function Code 66 (0x42)
Byte 2: Read Software Version Number Sub-Code

Response PDU:

Byte 1	Byte 2	Byte 3	...	Byte N-1	Byte N
Function Code (66)	Sub-Code (5)	ASCII	...	ASCII	NULL

Where,

Byte 3 - N: Software Version Number
Null Terminated ASCII String of up to 16 characters
Language Determined by Drive Parameter

Read Parameter Level Text (Sub-Code 6)

This PDU is used to read parameter division names from the control card.

Request PDU

Byte 1	Byte 2	Byte 3	Byte 4
Function Code (66)	Sub-Code (6)	Parameter Number	

Where,

Byte 1: Text Handing Function Code 66 (0x42)
Byte 2: Read Parameter Division Name Sub-Code
Byte 3-4: 16-Bit Parameter Number (PN)
16-bit signed integer
High to low data byte order

Response PDU:

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	...	Byte N-1	Byte N
Function Code (66)	Sub-Code (6)	Fault Code H	Fault Code L	ASCII	...	ASCII	NULL

Where,

Byte 5 - N: Parameter Division Name
For example, LEVEL 1 or LEVEL 2
Null Terminated ASCII String of up to 16 characters
Language Determined by Drive Parameter

Text Handling Continued

Read Parameter Block Text (Sub-Code 7)

This PDU is used to reads a parameter's block name from the control card.

Request PDU

Byte 1	Byte 2	Byte 3	Byte 4
Function Code (66)	Sub-Code (7)	Parameter Number	

Where,

Byte 1: Text Handing Function Code 66 (0x42)
Byte 2: Read Parameter Division Name Sub-Code
Byte 3-4: 16-Bit Parameter Number (PN)
16-bit signed integer
High to low data byte order

Response PDU:

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	. . .	Byte N-1	Byte N
Function Code (66)	Sub-Code (7)	Parameter Number		ASCII	. . .	ASCII	NULL

Where,

Byte 5 - N: Parameter Group Name
For example, PRESET SPEEDS or PROCESS CONTROL
Null Terminated ASCII String of up to 16 characters
Language Determined by Drive Parameter

Read Fault Log Text (Sub-Code 8)

This PDU is used to read fault log entries from the control card.

Request PDU

Byte 1	Byte 2	Byte 3	Byte 4
Function Code (66)	Sub-Code (8)	Group No.	Requested Entry

Where,

Byte 1: Text Handing Function Code 66 (0x42)
Byte 2: Read Fault Log Entry Sub-Code
Byte 3: Group Number
0 - Control card fault log
1 - Powerbase fault log
Byte 4: Requested Fault Log entry number (1-M)
Host should start 1
Can be read in any sequence
Modbus exception upon request of invalid entry number
Maximum number of entries, M, returned in response

Response PDU:

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8	Byte 9	Byte 10	Byte 11
Function Code (66)	Sub-Code (8)	Group No.	Requested Entry	Max Entries	M	M	/	D	D	/

Byte 12	Byte 13	Byte 14	Byte 15	Byte 16	Byte 17	Byte 18	Byte 19	Byte 20	Byte 21	Byte 22	Byte 23	Byte 24	Byte 25
Y	Y	Y	Y	Space	H	H	:	M	M	:	S	S	Space

Byte 26	Byte 27	. . .	Byte N
ASCII	ASCII	. . .	NULL

Where,

Byte 5: Maximum number of fault log entries
Bytes 6-15: ASCII month/day/year
Byte 16: ASCII space
Bytes 17-24: ASCII hour: minute: second
Byte 25: ASCII space
Bytes 26-N: ASCII fault code text of up to 16 characters

Text Handling Continued

Read Units Text (Sub-Code 9)

This PDU is used to read units text from the control card.

Request PDU

Byte 1	Byte 2	Byte 3
Function Code (66)	Sub-Code (9)	Units Test ID

Where,

Byte 1: Text Handing Function Code 66 (0x42)
Byte 2: Read Units Text Sub-Code
Byte 3: Units text ID as defined in parameter configuration PDU

Response PDU:

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte N
Function Code (66)	Sub-Code (9)	Units Test ID	ASCII	ASCII	NULL

Where,

Byte 4-N: Up to three character units text
Language independent

Write List Parameter Text (Sub-Code 10)

This PDU is used to write list parameter text to the control card.

Request PDU

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	. . .	Byte N-1	Byte N
Function Code (66)	Sub-Code (10)	PN H	PN L	Index H	Index L	ASCII	. . .	ASCII	NULL

Where,

Byte 1: Text Handing Function Code 66 (0x42)
Byte 2: Write List Parameter Text Sub-Code
Byte 3-4: 16-Bit Parameter Number (PN)
Byte 5-6: 16-Bit Index (1-Max) into List
Byte 7-N: 1 to 16 character Null terminated ASCII text string

Response PDU:

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6
Function Code (66)	Sub-Code (10)	PN H	PN L	Index H	Index L

Where,

Byte 4-N: Up to three character units text
Language independent

Parameter Support (H2 Function Code 67)

These sub-functions provide special parameter support functions.

Parameter Count (Sub-Code 1)

This PDU is used to the number of control card parameters supported.

Request PDU

Byte 1	Byte 2
Function Code (67)	Sub-Code (1)

Where,

Byte 1: Parameter Support function code 67 (0x43)
Byte 2: Parameter Count Sub-Code 1

Response PDU:

Byte 1	Byte 2	Byte 3	Byte 4
Function Code (67)	Sub-Code (1)	Count H	Count L

Where,

Byte 3-4: 16-bit parameter count

Parameter Configuration (Sub-Code 2)

This PDU is used to extract parameter data from the control card. Once the number of parameters supported on the card is known the master should enter into a loop and read parameter configuration data for each parameter using the following PDU.

Request PDU

Byte 1	Byte 2	Byte 3	Byte 4
Function Code (67)	Sub-Code (2)	Index H	Index L

Where,

Byte 1: Control Card Parameter Configuration Function Code 67 (0x42)
Byte 2: Parameter Configuration sub-code 2
Byte 2-3: Parameter Index (1≤x<Parameter Count)

Response PDU:

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	. . .	Byte 22	Byte 23
Function Code (67)	Sub-Code (2)	Index H	Index L	PN H	PN L	ASCII 1	. . .	ASCII 16	Class

Byte 24	Byte 25	Byte 26	Byte 27	Byte 28	Byte 29	Byte 30	Byte 31	Byte 32	Byte 33	Byte 34	Byte 35
ATTR H	ATTR L	Units	Data Type	SF HH	SF HL	SF LH	SF LL	Value HH	Value HL	Value LH	Value LL

Byte 36	Byte 37	Byte 38	Byte 39	Byte 40	Byte 41	Byte 42	Byte 43	Byte 44	Byte 45	Byte 46	Byte 47
Max HH	Max HL	Max LH	Max LL	Def HH	Def HL	Def LH	Def LL	Min HH	Min HL	Min LH	Min LL

Where,

Byte 1: Control Card Parameter Configuration Code 67 (0x43)
Byte 2: Parameter configuration sub-code 2
Byte 3-4: Parameter Index
Byte 5-6: Parameter Number (DD10025 spec)
Byte 7-22: Parameter Name (16 ASCII text characters, left justified and blank filled)
Byte 23: Class
- Bit0 - set for Inverter (I)
- Bit1 - set for Vector (V)
- Bit2 - set for Servo (S)

Byte 24-25: Parameter Attributes (ATTR)
- Bit0 - Read (R)
- Bit1 - Write (W)
- Bit2 - changeable while drive is enabled (DE)
- Bit3 - saved to EE
- Bit4 - Parameter Hidden
- Bit5 - Drive Parameter
- Bit6 - Changeable List Parameter
- Bit7 - 9 reserved
- Bit10 - parameter is speed units dependent
- Bit11 - parameter has monitor status
- Bit12 - parameter has o-scope support
- Bit13 - parameter has fault trace attribute
- Bit14 - parameter viewable by Workbench

Parameter Support Continued

Parameter Configuration (Sub-Code 2) Continued

Byte 26: Units
- 0 List Parameter (no units)
- 1 Gain or pure number (no units)
- 2 Bit Field (no units)
- 3 Volts (V)
- 4 Current (A)
- 5 Revolution/Minute (RPM)
- 6 Hertz (Hz)
- 7 Kilowatt (KW)
- 8 Watts (W)
- 9 Deg C
- 10 Amps/Volt
- 11 Percent (%)
- 12 Newton-Meters (NM)
- 13 Seconds (SEC)
- 14 Minutes (MIN)
- 15 Hours (HR)
- 16 Ohms (OHM)
- 17 Henrys (H)
- 18 Horse Power (HP)
- 19 Pulses/Revolution (PPR)
- 20 Counts (CNT)
- 21 Webers (Wb)
- 22 Revolutions (REV)
- 23 Days (DAY)
- 24 Months (MTH)
- 25 Years (YR)
- 26 Hz/sec
- 27 RPM/sec
- 28 Degrees
- 29 Milliamps (mA)
- 30 Megawatts (MW)
- 31 Kilowatt Hours (KWH)
- 32 Megawatt Hours (MWH)
- 33 Cost/KWH ($/KWH)
- 34 Cost $
- 35 Custom Units (read parameter number 3203, Units of Measure)

Byte 27: Data Type
- 0 IEEE 32-Bit Floating Point Number
- 1 Unsigned 32-Bit Integer
- 2 Signed 32-Bit Integer
- 3 Hexadecimal 32-Bit Integer
- 4 Binary 32-Bit Integer
- 5 Packed 4 character ASCII 32-bit Integer (8 bits/character)

Bytes 28-31: IEEE 32-Bit Floating Point Number Scale Factor (EE units->Internal Units)
Byte 32-35: Current Value
Bytes 36-39: Maximum Value
Bytes 40-43: Default Value
Bytes 44-47: Minimum Value

Parameter Support Continued

Parameter Upload (Sub-Code 3)

This PDU is used to provide parameter upload functionality from the drive to a host. Only parameters stored in the control's EE are uploaded. Only one multi-block Modbus operation may be performed at a time. The O-scope, parameter upload and parameter download all require multi-block support. They are sent in parameter index order, each parameter data set taking exactly six (6) bytes: two (2) for parameter number and four (4) for parameter value.

Each parameter table requires its own upload. A block number out of sequence aborts the upload.

Request PDU

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5
Function Code (67)	Sub-Code (3)	Parameter Table Number	Blocking Factor	Block Number

Where,

Byte 1: Parameter Support function code 67 (0x43)
Byte 2: Sub-Code 3 for parameter upload
Byte 3: Parameter Table Number: 1-4
Byte 4: Blocking Factor (BF)
$5 \leq BF \leq 40$
Maximum number of parameters packed into a PDU
Example:
Assume 305 parameters, and BF=30
305 = 10*BF + 5
Thus the total number of blocks is 11
The first 10 blocks contain 30 parameters
Block 11, the last block, contains the last 5 parameters
Byte 5: Block Number (0 - N)
Host must start with block 0, the header block
Blocks 1 - N contain parameter data
Total number of blocks, N, returned by he drive in the header defined below

Response PDU: Drive Response Block 0 (Header Block)

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8	Byte 9	Byte 10
Function Code (67)	Sub-Code (3)	Block Number	Parameter Table Number	Parameter Count		Blocking Factor	Total Blocks	CRC	

Where,

Byte 3: Block number 0 (header)
Byte 4: Parameter Table Number: 1-4
Byte 5-6: Parameter Count
16-bit integer
Data in high to low byte order
Byte 7: Blocking factor
Byte 8: Total number of blocks not counting the header block
Byte 9-10: CRC
Modbus CRC-16 algorithm
16-bit unsigned integer
Data in high to low order
Computed over ALL parameter data value bytes

Response PDU: Drive Response 1-N (Data Blocks)

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8	Byte 9	...
Function Code (67)	Sub-Code (3)	Block Number	Parameter Number		Parameter Value				...

Byte M-5	Byte M-4	Byte M-3	Byte M-2	Byte M-1	Byte M
Parameter Number		Parameter Value			

Where,

Byte 3: Block number: 1-N (data)
Bytes 4-5: Parameter number in high to low byte order
Bytes 6-9: Corresponding parameter value in high to low byte order
Bytes M-5 to M: Last parameter number and value needed to complete the block

Parameter Support Continued

Parameter Download (Sub-Code 4)

This PDU is used to provide parameter download functionality from a host to the drive. Only parameters stored in the control's EE are downloaded. Only one multi-block Modbus operation may be performed at a time. The O-scope, parameter upload and parameter download all require multi-block support. They are sent in parameter index order, each parameter data set taking exactly six (6) bytes: two (2) for parameter number and four (4) for parameter value. The drive must be disabled before and remain disabled during downloads else a Modbus Exception results.

Parameter numbers and values are held in a buffer until all parameters have been received by the drive and there is a CRC match. The drive then attempts to update parameters one at a time in the order received. Although parameters may be added or subtracted across software versions, so long as a parameter exists its number and meaning remain unchanged. This allows old parameter files to be downloaded to new drive software and new parameter files to be downloaded to old drive software. Even if a parameter is rejected by the drive, a download continues; but after it completes a parameter initialization error is issued.

Each parameter table requires its own download. A block number out of sequence aborts the download.

Request PDU

Host Block 0 (Header Block is first block sent)

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8	Byte 9	Byte 10
Function Code (67)	Sub-Code (4)	Block Number	Parameter Table Number	Parameter Count		Blocking Factor	Total Blocks	CRC	

Where,

Byte 1: Parameter Support function code 67 (0x43)
Byte 2: Sub-Code 4 for parameter download
Byte 3: Block number 0 (header)
Byte 4: Parameter Table Number: 1-4
Byte 5-6: Number of parameters
16-bit integer
Data in high to low order
Byte 7: Blocking factor
5 = BF = 40
Maximum number of parameters packed into a PDU
Byte 8: Total number of blocks not counting the header block
Byte 9-10: CRC
Computed over all parameter data value bytes in the download
16-bit unsigned integer
Modbus CRC
Data in high to low order

Host Blocks 1-N (Data Blocks)

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8	Byte 9	...
Function Code (67)	Sub-Code (4)	Block Number	Parameter Number		Parameter Value				...

Byte M-5	Byte M-4	Byte M-3	Byte M-2	Byte M-1	Byte M
Parameter Number		Parameter Value			

Where,

Byte 3: Block number: 1-N (data)
Bytes 4-5: Parameter number in high to low byte order
Bytes 6-9: Corresponding parameter value in high to low byte order
Bytes M-5 to M: Last parameter and value needed to complete the block

Response PDU: Drive Response

Byte 1	Byte 2	Byte 3
Function Code (67)	Sub-Code (4)	Block Number

Where,

Byte 1: Parameter Support function code 67 (0x43)
Byte 2: Sub-Code 4 for parameter download
Byte 3: Block Number: 0-N

Parameter Support Continued

Read Parameter Dynamic Fields (Sub-Code 5)

This PDU is directed towards the active parameter table only. It is used to read the current settings for fields within a parameter that are subject to change.

Request PDU

Byte 1	Byte 2	Byte 3	Byte 4
Function Code (67)	Sub-Code (5)	Parameter Number	

Where,

Byte 1: Parameter Support function code 67 (0x43)
Byte 2: Parameter dynamic fields Sub-Code
Byte 3-4: 16-Bit Parameter Number (PN)

Response PDU:

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8	Byte 9	Byte 10	Byte 11	Byte 12
Function Code (67)	Sub-Code (5)	Parameter Number		Maximum Value				Default Value (Factory Setting)			

Byte 13	Byte 14	Byte 15	Byte 16	Byte 17	Byte 18	Byte 19	Byte 20	Byte 21	Byte 22	Byte 23
Current Value				Minimum Value				Units	Data Type	Resolution

Where,

Bytes 5-8: Maximum parameter value (Data in high to low byte order)
Bytes 9-12: Parameter default value (Data in high to low byte order)
Bytes 13-16: Parameter current value (Data in high to low byte order)
Bytes 17-20: Parameter minimum value (Data in high to low byte order)
Byte 21: Units as defined in the configuration PDU
Byte 22: Data type as defined in the configuration PDU
Byte 23: Digits to the right of the decimal point (resolution)

Read Parameter Fields from Parameter Table (Sub-Code 6)

This PDU allows access to parameter fields as they exist within the parameter tables. It is used to read certain fields as defined below within a parameter.

Request PDU

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5
Function Code (67)	Sub-Code (6)	Table Index	Parameter Number	

Where,

Byte 1: Parameter Support function code 67 (0x43)
Byte 2: Parameter dynamic fields Sub-Code
Byte 3: Parameter table index (0-3)
Byte 4-5: 16-Bit Parameter Number (PN)

Response PDU:

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8	Byte 9	Byte 10	Byte 11	Byte 12	Byte 13
Function Code (67)	Sub-Code (6)	Table Index	Parameter Number		Maximum Value				Default Value (Factory Setting)			

Byte 14	Byte 15	Byte 16	Byte 17	Byte 18	Byte 19	Byte 20	Byte 21	Byte 22	Byte 23	Byte 24
Current Value				Minimum Value				Units	Data Type	Resolution

Where,

Bytes 6-9: Maximum parameter value (Data in high to low byte order)
Bytes 10-13: Parameter default value (Data in high to low byte order)
Bytes 14-17: Parameter current value (Data in high to low byte order)
Bytes 18-21: Parameter minimum value (Data in high to low byte order)
Byte 22: Units as defined in the configuration PDU
Byte 23: Data type as defined in the configuration PDU
Byte 24: Digits to the right of the decimal point (resolution)

Poll Controller

This PDU is used when the response time from the slave is longer than normal. It provides a way to avoid a timeout. Normally a Modbus Master sends a request and waits for the slave to respond. If the slave does not respond within a fixed time-period a time-out has occurred and the Master can send another request. This is how standard function codes are supported. Standard function codes do not support the Poll Controller Function Code.

For standard function codes, if the master sends another request before the slave has responded, the slave responds with the exception code SLAVE DEVICE BUSY. In this case, there is a chance that the master and slave could transmit at the same time thereby corrupting the message.

Special H2 functions codes do support the Poll Controller Function Code. Some of these codes take an indeterminate amount of time to complete. In this case, polling is used. Consider the following sequence.

The master sends a special H2 function code request PDU.

Byte 1	**Byte** 2	**Byte n**	**. . .**
Function Code (14)	Data	Data	**. . .**

The slave responds with a Modbus Exception:

Byte 1	**Byte** 2	**Byte n**	**. . .**
Function Code (14)	Data	Data	**. . .**

The master must now poll the slave for a response. The slave will not respond automatically. If at any time after an ACKNOWLEDGE the master fails to poll but instead makes another request, the slave shall respond with an ILLEGAL FUNCTION exception.

The master polls the slave using PDU.

Byte 1
Poll Controller (14)

The slave responds with PDU:

Byte 1	**Byte** 2
Poll Controller (14)	SLAVE DEVICE BUSY (06)

The master continues polling the slave so long as the SLAVE DEVICE BUSY exception code is returned.

The polling sequence ends upon any of the following responses from the slave:

The response PDU to the original PDU request is returned

A Modbus exception other than ACKNOWLEDGE or SLAVE DEVICE BUSY is returned.

The following time table shows a typical polling sequence.

Time	**Master**		**Slave**
0	PDU1	→	
1		←	Acknowledge
2	Poll Controller	→	
3		←	Slave Device Busy
4	Poll Controller	→	
3		←	Slave Device Busy
4	Poll Controller	→	
		←	Slave Device Busy
•	•	•	•
N	Poll Controller	→	
N+1		←	Response PDU1
N+2	PDU2	→	

Error Messages

Message Display	Description
ADDRESS_OUT_OF_RANGE	Error addressing Flash
AL_SUCCESS	no error
ALL_AXES_MUST_BE_OFF	All Axes must be configured Off.
ALL_CONTROL_AXES_IN_USE	All controllable axes in use
AUTOTUNE_FAILURE	Autotuning operation failed
AXIS_NOT_COMMISSIONED	The axis/drive is not commissioned.
AXIS_NOT_RIGHT_TYPE	action denied when in wrong config
BBP_BLOCK_NOT_ACCEPTED	BBP Block transfer not accepted
BBP_DATA_OUT_OF_BOUNDS	BBP Transaction data modified
BBP_DATA_OUT_OF_RANGE	BBP Transaction data invalid
BBP_END_OF_BLOCK_REACHED	BBP End of block reached
BBP_FAULT_PREVENTS_EXEC	BBP Transaction can't be executed
BBP_MODE_PREVENTS_EXEC	BBP Transaction can't be executed
BBP_OVERFLOW	BBP Transaction Rx overflow
BBP_REQUEST_TIMEOUT	Timeout on BBP request.
BBP_TRANSACTION_IN_PROGRESS	A BBP transaction is executing.
CALC_OPERATION_FAILED	Calculation operation generated unexpected results
CAN_ALREADY_CONNECTED	CANopen node is already connected to another node.
CAN_BUS_OFF	The CAN controller is bus off.
CAN_CONFIRMED_BUSY	A confirmed service is already in progress.
CAN_ERROR	Unable to initialise the CAN bus
CAN_INVALID_CHANNEL	CAN node channel out of range
CAN_INVALID_OBJECT	Invalid CAN object
CAN_INVALID_OBJECT_ACCESS	Invalid access to a CAN object
CAN_INVALID_SUBINDEX	Invalid subIndex for CAN object
CAN_MESSAGE_COBID_DISABLED	CAN message is disabled in the COB_ID
CAN_MESSAGE_NMT_DISABLED	CAN message is disabled by the NMT state
CAN_PROTOCOL_ERROR	CAN Protocol Error During Communication.
CAN_RESERVED_OBJECT	Reserved CAN object
CAN_TIMEOUT	Failed to receive reply in time
CAN_TX_BUFFER_FULL	The CAN transmit buffer was full.
CAN_VALUE_OUT_OF_RANGE	Data specified out of range
CANNOT_CONTOUR_AND_BLEND	Can't contour and blend at same time.
CAPTURE_CHANNEL_MIX	Invalid cpature channel mix.
CAPTURE_IN_PROGRESS	Capture in progress during upload
CHANNEL_IN_USE	Hardware channel required is in use
CHANNEL_NOT_RIGHT	Channel incorrectly configured
CMS_DATABASE_FULL	All CMS COBIDs have been allocated
COMMANDED_OPERATION_FAILED	Commanded operation failed
COMMS_READ_ONLY	COMMS element is read only.
COMMS_RESERVED_ELEMENT	COMMS reserved element
CRC_CHECKSUM_ERROR	Error in received Checksum
DB_ERROR	Initialise daughter board failed
DEBUG_DISABLED	Debug keywords are disabled.
DENIED_DUE_TO_POLLING	an invalid command was received during a polling sequence
DOWNLOAD_TIMEOUT	Timeout during File Download.
DPR_TIMEOUT	DPR timeout
DRIVE_DISABLED	Drive is not enabled
DRIVE_ENABLED	Drive is enabled.
DRIVE_FAULT_STATUS	Drive fault status prevented action being taken
DRIVE_TIMEOUT	BBP Transaction timed-out
DSP_COMMS	Inter-processor communications error
DSP_FAILED_TO_CLEAR_ERROR	DSP Failed to clear the error.

Message Display	Description
EE_DEVICE_FAILURE	Operation on EE device failed
EEPROM_ACCESS	Error accessing EEPROM device
FEEDBACK_COMMS_BUSY	Feedback device comms is busy
FEEDBACK_DATUM_ERROR	Feedback device is unable to datumise
FEEDBACK_ERROR	Feedback device has error
FEEDBACK_MESSAGE_CORRUPT	Feedback device comms message is corrupt
FEEDBACK_MOTOR_DATA_ERROR	Motor data stored on encoder is invalid
FEEDBACK_NOT_RESPONDING	Feedback device comms is not responding
FIELDBUS_INIT_ERROR	Error initialising the Fieldbus card
FIELDMARSHAL_EEPROM_ACCESS	Error accessing FieldMarshal EEPROM
FILE_PROTECTED	Mint File is Protected.
FILE_TOO_BIG	File too big for available memory
FLASH_BEING_PROGRAMMED	Command invalid when Flash in use
FLASH_PROGRAMMING	Error programming Flash
ICM_ARRAY_ERROR	ICM protocol error
ICM_BLOCK_TOO_BIG	ICM protocol error
ICM_DATA_TIMEOUT	ICM Timeout
ICM_DISABLED	ICM is disabled on this channel
ICM_DLL_ERRORS	Errors in the Rxd DLL SO telegram
ICM_DLL_MESSAGE_ID_MISMATCH	DLL SO telegram id doesn't match
ICM_HOST_BUSY	The host is not ready for the ICM reply
ICM_RETURN_TIMEOUT	ICM Timeout
ICM_TL_BUSY	TL is busy - still processing command
ICM_TL_GROUP_MESSAGE_ID	Group message id mismatch
ICM_TL_GROUP_SEQUENCE	Group message packet No out of sequence
ICM_TL_HOST_RETRANSMITS	Too many host retransmit requests
ICM_TL_NO_OF_PACKETS	Invalid No of packets specified
ICM_TL_TRANSMIT_REQUESTS	Too many transmit requests - timed-out
ICM_TOO_MANY_ARRAYS	ICM protocol error
ICM_TX_SIZE_MISMATCH	ICM protocol error
INCOMPATIBLE_CONTROL_MODE	Incompatible control mode.
INCOMPATIBLE_PARAMETER_TYPE	Incompatible parameter data type
INCOMPATIBLE_SETTINGS	Incompatible with previous settings
INCORRECT_CRC_ERROR	Received Modbus PDU CRC failed
INCORRECT_PDU_LENGTH_ERROR	Received Modbus PDU length did not match
INCORRECT_REF_SOURCE	Reference source is not Host when trying to set a speed ref using Mint keyword
INITIALISATION_FAILURE	A failure occurred during initialisation
INVALID_ALLOCATION_TABLE	Invalid object allocation table
INVALID_AXIS	axis specified out of range
INVALID_AXISMODE	Move not allowed in this mode.
INVALID_BBP_FIELD_LENGTH	BBP Transaction has wrong length
INVALID_BBP_PACKET_SIZE_RXD	BBP Transaction Rxd size too big
INVALID_BBP_TRANS_NO	BBP Transaction No. not supported
INVALID_BBP_TRANSACTION_RXD	Invalid BBP Transaction Rxd
INVALID_BUS_NUMBER	CAN bus number was out of range.
INVALID_CHANNEL	adc / dac channel out of range
INVALID_COIL	An invalid coil number was received
INVALID_DATA_ELEMENT	A packet was received with at least one data element out of range
INVALID_DISCRETE_INPUT	An invalid discrete input number received
INVALID_DRIVE_CONTROL_MODE	Operation is invalid in this drive control mode
INVALID_DRIVE_PARAM	Invalid Drive Parameter No.
INVALID_EE_DEVICE_ID_NUMBER	An invalid EE device ID number was received
INVALID_HARDWARE	Hardware not present
INVALID_IMAGE_FORMAT_CODE	The image files format is invalid

Message Display	Description
INVALID_INPUT	digital input out of range
INVALID_LOCAL_NODE	Local CAN node not correct.
INVALID_MASTER_CHANNEL	Master Channel invalid for Axis.
INVALID_MINT_COMMAND	The Mint command is invalid
INVALID_MODE	invalid error action mode
INVALID_NODE_ID	CAN node number out of range
INVALID_NUM_CAP_PTS	Invalid number of capture points
INVALID_OUTPUT	digital output out of range
INVALID_PLATFORM_CODE	The image files platform is invalid
INVALID_POINTER	addresses area outside memory
INVALID_REGISTER_ADDRESS	An invalid Modbus register address received
INVALID_REMOTE_BAUD	Node doesn't support baud rate
INVALID_STATIC_CHUNK	Invalid chunk specified for static.
INVALID_STATIC_HANDLE	Invalid handle for static variable.
INVALID_SUBFUNCTION_CODE	Received Modbus Invalid Sub-function code
INVALID_TERMINAL_ADDRESS	Address type for terminal is not valid
INVALID_TERMINAL_DEVICE	Device for terminal is not valid
INVALID_TERMINAL_PORT	Port type for terminal is not valid
INVALID_VAR_TYPE	Invalid variable type for RemoteObject.
KNIFE_AXES_NOT_CONFIGURED	The axes for knife control not set
KNIFE_HANDLER_NOT_INSTALLED	Need a KNIFE handler for knife control
KNIFE_ROTATION_OUT_OF_RANGE	Knife rotation out of range
MB_INVALID_BLOCK_ERROR	Invalid Modbus blocknumber
MINT_PROGRAM_RUNNING	A Mint program is already running
MML_ERROR	syncronous MML error
MML_NOT_SUPPORTED	MML does not support this function
MODE_INVALID_STATUS	Drive mode prevented action being taken
MOTION_ERROR	general motion (async) error
MOTION_IN_PROGRESS	action denied when axis in motion
MOVE_BUFFER_FULL	Move buffer is full
MOVE_BUFFER_NOT_EMPTY	Move buffer is not empty.
NETWORK_MODE	Must be in network mode to perform this operation
NO_BBP_TRANSACTION_REQUESTE	No BBP transaction requested.
NO_CONNECTION	No Connection Exists
NO_FREE_CAN_OBJECTS	There were no free message objects left in the CAN controller.
NO_INPUT_SPECIFIED	op on home/limit etc with no i/p
NO_OUTPUT_SPECIFIED	op on enable output with no o/p
NODE_NOT_LIVE	node is not LIVE
NON_VOLATILE_MEMORY_ERROR	Problems with non-volatile memory
NOT_NETWORK_MASTER	Must be master of network
OBJECT_NOT_FOUND	Application data object not found
OFFSET_PROFILE_ERROR	The Offset cannot be Profiled
OPIONAL_CARD_NOT_INSTALLED	Option card not installed or defective
OSCOPE_ACTION_DENIED	An invalid o-scope command was received during data capture
OSCOPE_NOT_CONFIGURED	O-scope has not been configured to allow this operation
OUT_OF_MEMORY	not enough heap for operation
OUTPUT_FAULT	Fault on the digital outputs.
OUTPUT_IN_USE	Output is already in use.
PARAMETER_ACCESS_CONFLICT	Two devices updating same parameter
PARAMETER_MODE_ERROR	Parameter cannot be changed
PARAMETER_TABLE_DOWNLOAD	Can't download Parameter Table.
PARAMETER_TABLE_INDEX	Parameter index is out of sequence
PARAMETER_TABLE_PLATFORM	Parameter Table doesn't match platform
PARAMETER_TABLE_VERSION	Parameter Table version not supported

Message Display	Description
PARAMETERS_LOCKED	Parameter are momentarily locked
PHASE_SEARCH_RUNNING	Phase search is in progress
READ_ONLY	Parameter is read only
REALTIME_CLOCK_FAILURE	Realtime clock hardware failure
REGISTER_READ_ONLY	Register is read only
REMOTE_DOWNLOAD_IN_PROGRESS	A Mint file is currently being downloaded to a remote node.
REMOTE_DRIVE_DISABLED	The remote drive is disabled (CANopen).
REMOTE_DRIVE_FAULT	The remote drive is in fault mode (CANopen).
REMOTE_DRIVE_MOVE_FAILED	The remote drive failed to accept the new move (CANopen).
REMOTE_EE_FAIL	Problem writing to EEPROM on node
REMOTE_ESTOP_ACTIVE	Node in ESTOP condition
REMOTE_MODE_NOT_PROGRAMMED	Remote mode is not programmed
REMOTE_STATE_INCORRECT	Transaction aborted due to nodes state.
REMOTE_SYNC_ERROR	Node reported a synchronous error
SERIAL_ERROR	Problem with RS232 or RS485 port.
SINGLE_TERMINAL_ONLY	A single terminal is required
STATIC_DATA_OVERRUN	Static filled, but data remains.
STATIC_DATA_UNDERRUN	Data consumed, but static not filled.
TABLE_ERROR	Bad Spline or cam table info
TERMINAL_BUFFER_EMPTY	Terminal Buffer is empty
TERMINAL_BUFFER_FULL	Terminal Buffer is full
TERMINAL_OUT_OF_RANGE	Port value is out of range
TERMINAL_UNAVAILABLE	No terminal device
TOO_MANY_TASKS	Too many tasks in Mint program
TRANSFER_IN_PROGRESS	A parameter table transfer is already in progress
TRANSFER_NOT_READY	Drive has not been prepared for parameter table transfer
TYPE_NOT_SUPPORTED	type of node not supported
UNDEFINED_TERMINAL	Terminal is not defined
UNKNOWN_BBP_ERROR	Unknown BBP error code
USB_BABBLE_ERROR	USB Babble Error
USB_BIT_STUFFING_ERROR	USB Bit Stuffing Error
USB_DATA_CRC_ERROR	USB Data CRC Error
USB_NAK_RECEIVED	USB Sent or Received a NAK
USB_OVERFLOW_ERROR	USB Overflow; the received packet was larger than available buffer space
USB_PACKET_UNEXPECTED	USB Packet is not of the expected type
USB_PID_ENCODING_ERROR	USB PID Encoding Error
USB_PID_UKNOWN	USB PID Unkown
USB_SENT_EMPTY_PACKET	USB Sent Empty Packet (ISOCHRONOUS MODE ONLY)
USB_SENT_STALL	USB Sent Stall; a token was received but the endpoint was stalled
USB_SYNC_ERROR	USB Sync Error
USB_TIME_OUT_ERROR	USB Time-Out Error
USB_TOKEN_CRC_ERROR	USB Token CRC Error
USB_UNEXPECTED_EOP	USB Unexpected End of Packet
USB_WRONG_TIGGLE_BIT	USB Wrong Toggle Bit in the DATA PID; data was ignored
VALUE_OUT_OF_RANGE	data specified out of range
VARIABLE_NOT_FOUND	Static variable not found.
WRONG_NODE_TYPE	node referenced not expected type
WRONG_PLATFORM	Not available on this controller

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